

# Design and implementation of the United States National Animal Health Monitoring System 1994–95 Cattle on Feed Evaluation, and an evaluation of the impact of response biases

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## Abstract

The 1994–95 Cattle on Feed Evaluation was a cooperative project (sponsored by the United States Department of Agriculture) involving Washington State University, state agricultural departments, and several agencies of the United States Department of Agriculture). The project focused on cattle-on-feed operations in 13 states that accounted for over 85% of the United States cattle on feed inventory. Participants were selected from National Agricultural Statistics Service list frames. Questionnaires were administered by telephone to operations with a one-time capacity of fewer than 1000 cattle; larger operations were visited twice to administer questionnaires.

The participation rate for the first phase of the study was 56.7%. Ninety-one percent of eligible operations completed the second phase of the study.

Data summarized from this national study can be used to profile management practices on cattle-feeding operations in the United States. Differences between participants and non-participants did not appear to be great. However, one does need to be mindful of the fact that a small percentage of the producers accounted for the vast majority of feedlot cattle marketed when interpreting the results. © 1997 Elsevier Science B.V.

**Keywords:** National survey; Cattle-on-feed; Survey design; Survey implementation; Nonresponse analysis; Product quality

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## 1. Introduction

The United States Department of Agriculture (USDA): Animal and Plant Health Inspection Service (APHIS): Veterinary Services (VS), National Animal Health Monitoring System (NAHMS) was created to address the animal health information needs of producers, consumers, agribusiness, academia, and animal health regulatory officials in the United States (Bush and Gardner, 1995; Hueston, 1990; King, 1990). The 1994 Cattle on Feed Evaluation (COFE) was the fourth national survey of the NAHMS program. The primary objective of the COFE was to identify management practices being employed in feedlots throughout the major cattle-feeding regions of the United States.

The objective of this paper is to describe how the COFE was designed and implemented, and to report examinations of possible biases in the data. In addition, study results related to product quality (i.e. branding and injection of clostridial vaccines) are presented.

## 2. Materials and methods

Details on most aspects of the COFE, including copies of all questionnaires and descriptions of data sets, are available in a technical report (USDA, 1996). Briefly, before the study began an assessment of the information needs was undertaken in order to establish the objectives of the study. Representatives of the National Cattlemen's Beef Association, veterinary organizations (the Academy of Veterinary Consultants and the American Association of Bovine Practitioners), and the USDA: Animal and Plant Health Inspection Service: Veterinary Services met with NAHMS personnel to discuss their information needs. In addition, Rockwood Research (1993) conducted a survey of feedlot operations that had marketed between 100 and 1000 cattle during 1992 to assess their information needs. The most important information needs identified served as the basis for drafting descriptive report table shells. Survey questionnaires were developed from the table shells.

### 2.1. Study design and implementation

The study design was a joint effort between the USDA: APHIS: VS, Centers for Epidemiology and Animal Health and the USDA: National Agricultural Statistics Service (NASS). NASS collects and reports feedlot inventory information from surveys monthly in seven states (Arizona, California, Colorado, Iowa, Kansas, Nebraska and Texas) and quarterly in six more states (Idaho, Illinois, Minnesota, Oklahoma, South Dakota and Washington). Participation in the COFE was limited to these 13 states, which accounted for 85.8% of the 1 January 1994 cattle inventory on feedlots in the United States (Glenda Shepler, USDA: NASS, Agricultural Statistics Service Board).

Fig. 1 presents the percent of the 1 January 1994 cattle-on-feed inventory for the 13 states included in the COFE. Three states (Texas, Nebraska and Kansas) accounted for more than half of the total inventory.

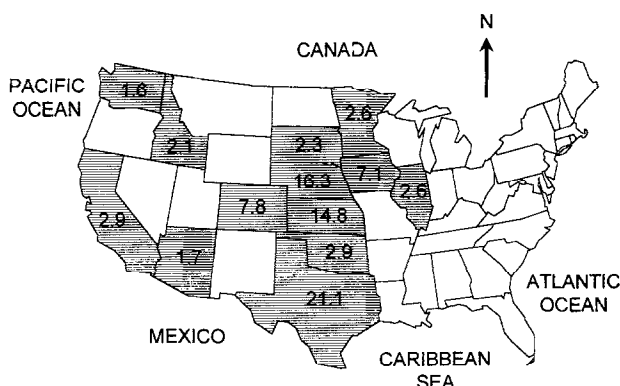


Fig. 1. States participating in the NAHMS 1994 Cattle on Feed Evaluation and Percent of United States Cattle-on-Feed Inventory, 1 January 1994. Three states (Texas: 21.1%; Nebraska: 16.3%; and Kansas: 14.8%) accounted for more than half of the total inventory. Total: 85.8% of United States inventory. Source: Cattle on Feed Report No. Mt An 2-1 (2-94), released 18 February 1994 by the USDA: NASS, Agricultural Statistics Board.

During 1993, cattle-on-feed operations with a one-time capacity of fewer than 1000 cattle accounted for 96.0% of the operations, but marketed only 12.7% of the feedlot cattle in the 13 participating states (Cattle on Feed Report No. Mt An 2-1 (2-94), released 18 February 1994 by the USDA: NASS: Agricultural Statistics Board).

## 2.2. Sample selection

Producers selected for inclusion in the COFE were a subset of producers selected for the NASS Cattle on Feed Survey. Producers selected for the NASS Cattle on Feed Survey were, in turn, a subset of the producers that had been selected for the 1 January 1994 NASS Cattle and Sheep Report. The NASS list-sampling frame was based on any information which NASS could obtain (for example, previous surveys and, in some states, state agricultural census records). No area-sampling frames were used.

The 1 January 1994 NASS Cattle and Sheep Report's stratification was based on a mix of size groupings by selected control variables by state on the NASS list-sampling frame. The control variables were determined by cattle-on-feed (one time capacity), number of sheep, milk cows and total cattle. Operations were assigned to the highest stratum number possible.

To support the NASS Cattle on Feed Estimation Program, NASS selected a subset of the operations that had been selected for the NASS Cattle and Sheep Report. The list-sampling frame was re-stratified based on data on cattle-on-feed capacity. Sample sizes for the NASS Cattle on Feed Estimation Program were established for state-specific strata. NASS created a total of 108 sampling strata for the program.

Within each stratum, operations were sorted from largest to smallest. Operations that had refused to participate in the NASS Cattle and Sheep Report or that had been

inaccessible during data collection for the NASS Cattle and Sheep Report were included at the end of the sort. Cattle-on-feed operations that were known not to have had any cattle or that were known to be out of business (based on information gathered at the time of interview for the NASS Cattle and Sheep Report) were disqualified from taking part in the NASS Cattle on Feed Estimation Program. Chromy's procedure, which is a sequential procedure for probability sampling with minimum replacement, was used to select the sample of operations for the NASS Cattle on Feed Estimation Program (Chromy, 1981).

Finally, the cattle-on-feed operations for the COFE were selected from among those operations that had been selected for the NASS Cattle on Feed Estimation Program. Generally, the largest producers in each state were selected with certainty. For strata composed of smaller producers, approximately one-half of the producers that had been selected for the NASS Cattle on Feed Estimation Program were randomly selected for inclusion in the COFE.

### *2.3. Promotion*

Prior to the launch of the survey, NASS sent a letter and an informational brochure on the COFE to producers selected for participation in the COFE. The letter mentioned the endorsement of the study by the National Cattlemen's Association and by the President-Elect of the American Association of Bovine Practitioners. Producers participating in the survey were promised fact sheets containing national results. Producers were told that their participation in the COFE was voluntary and that the information they provided would be considered confidential.

### *2.4. Training and pre-test*

A VS coordinator was assigned for each participating state in February, 1994. The 13 VS state coordinators received training on the study objectives and the use of the survey instruments prior to training the data collectors in each of their states. In addition, NASS invited VS coordinators to participate in the training of NASS enumerators.

The COFE survey instruments were pre-tested in May and August, 1994. Each VS state coordinator visited one cattle-on-feed operation in his or her state, administered the draft questionnaires, and provided suggestions on improving the questionnaire to the Centers for Epidemiology and Animal Health.

### *2.5. Data collection*

The COFE consisted of two phases.

#### *2.5.1. Phase 1*

During the first phase of the COFE (1 August to 16 September 1994), NASS telephone interviewers contacted selected operations identified as having a one-time

capacity of fewer than 1000 cattle. In addition, NASS enumerators visited larger operations to administer questionnaires. If the operator of an operation with a one-time capacity of 1000 or more cattle indicated his willingness to continue in the study by signing a consent form, NASS turned the operator's name over to VS for Phase 2. All operations with a one-time capacity of 1000 or more cattle that had participated in Phase 1 were entitled to participate in Phase 2, provided they remained in business and had cattle at the time of the Phase 2 visit.

### *2.5.2. Phase 2*

From 3 October to 21 December 1994, a state or federal veterinary medical officer visited each operation whose operator's name was given by NASS to VS. The veterinary medical officer administered a questionnaire relating to the health-management practices used on the operation.

## *2.6. Data entry and validation*

NASS data entry specialists entered data collected by NASS enumerators into a SAS database and validated the data according to specifications furnished by the Centers for Epidemiology and Animal Health. Centers for Epidemiology and Animal Health staff entered data collected by visiting veterinary medical officers and animal health technicians into SAS data sets. Validation included assuring that subtotals added correctly, percentages added to 100 (where required), skip patterns were followed correctly, and that data were within expected ranges. Data outside expected ranges were verified personally by state coordinators and, where necessary, the veterinary medical officers.

## *2.7. Participation analysis*

A chief purpose of the participation analysis was to examine whether information reported from the COFE might have been biased by differences between COFE participants and those operations that had either refused to participate in the study or had not been accessible when contact was attempted.

### *2.7.1. Phase 1*

Participation rates were computed by state and feedlot capacity. The results were tested for significant differences ( $P < 0.05$ ) using the chi-square test in SAS's FREQ procedure (Statistical Analysis Systems Institute Inc., 1990).

### *2.7.2. Phase 2*

Participation rates by a number of key variables (from the Phase 1 questionnaire) were computed and tested for differences using the chi-square test in SAS's FREQ procedure (Statistical Analysis Systems Institute Inc., 1990). The TTEST procedure of SAS (Statistical Analysis Systems Institute Inc., 1990) was used to compare mean death loss (number of cattle that died as a percent of number of cattle that entered the feedlot from 1 July 1993 to 30 June 1994) between Phase 2 participants and non-participants.

## 2.8. Weight creation

An operation's sample weight was the number of cattle-on-feed operations (in the population) which a sampled operation represented for the purpose of creating population estimates from the study. Since smaller operations were sampled at a lower rate than large operations, smaller operations generally received larger weights than larger operations.

### 2.8.1. Phase 1

For each operation, the initial sample weight was the inverse of the sampling fraction in its NASS sampling stratum.

Phase 1 participants and operations in business but with no current inventory were treated the same for weight adjustment purposes. Both are called 'respondents'.

Non-respondents included those operations that:

1. had not been accessible when contact for the COFE was attempted; or
2. had refused to participate in the COFE when contacted.

To redistribute sample weights from Phase 1 non-respondents to respondents, a non-response adjustment factor was created for each of 23 poststrata. A poststratum is a stratum to which a sampling unit is assigned after the survey has been conducted (Sukhatme and Sukhatme, 1970). The poststrata were based on feedlot capacity and region, with  $\geq 20$  Phase 1 participants in each poststratum.

The non-response adjustment factor for each respondent was the sum of the initial sample weights of all respondents and non-respondents within its poststratum, divided by the sum of the initial sample weights of the respondents in its poststratum.

The product of the initial sample weight and the non-response adjustment factor yielded a non-response adjusted sample weight for each respondent.

Non-respondents received a non-response adjusted sample weight of zero. Weights of ineligible operations (i.e. operations that were out of business, and university, research, and other institutional feedlots) were not adjusted for non-response.

The weights were adjusted again to force the COFE estimate of the total number of cattle placed on feed from 1 July 1993 to 30 June 1994 to match the number published by NASS for each of eight region by feedlot capacity classes. Each weight was multiplied by the ratio of the number published by NASS to the number estimated from the COFE data.

### 2.8.2. Phase 2

Procedures similar to those described for Phase 1 were designed to redistribute Phase 1 sample weights from the operations that were entitled to but did not participate in Phase 2 to the operations that participated in Phase 2.

## 2.9. National estimates

Population estimates (of means and proportions) and standard errors were obtained using SUDAAN, a program specifically designed for survey data analysis (Shah et al., 1996). SUDAAN uses first-order Taylor-series approximation to estimate standard errors (Shah et al., 1996).

### 3. Results

#### 3.1. Participation

##### 3.1.1. Phase 1

The NASS procedure selected 6338 cattle on feed operations (Table 1). More than half of the selected operations were not contacted because they were known by NASS to be out of business or to have no inventory. Although not contacted for the COFE, these operations remained on the list to be sampled for the purpose of maintaining their weights in the computation of national estimates of cattle-on-feed operations, so as to remain consistent with NASS procedures for computing national inventory estimates. (NASS does continue to return to these operations for its cattle-on-feed reports).

Of the 2489 qualified producers, 1411 (56.7%) participated in Phase 1. This figure assumes that all of the operations that refused to participate in Phase 1 or were not accessible were qualified for the COFE (i.e. were in business and in scope at the time of attempted contact). No measure exists as to the extent to which this assumption is erroneous. Therefore, the computed Phase 1 participation rate may be conservative.

The Phase 1 participation rate was significantly higher ( $\chi^2 = 32.87$ , d.f. = 1,  $P <$

Table 1

Disposition of feedlot operations selected by NASS for the first phase of the COFE

Disposition	Operations with one-time capacity of < 1000 cattle	Operations with one-time capacity of $\geq$ 1000 cattle	All operations
<i>Not contacted because of knowledge at selection to have:</i>			
-been out of business	344	25	367
-had zero inventory	2663	186	2849
<i>Did not respond because:</i>			
-operator not accessible	116	50	166
-operator refused to respond	459	453	912
<i>Responded, but did not participate because:</i>			
-operation out of business	34	21	55
-operation out of scope <sup>a</sup>	4	6	10
-operation had no inventory of cattle-on-feed	514	54	568
<i>Responded in Phase 1:</i>			
-telephone interview	913	0	913
-participated in NASS enumerator visit and agreed to have name turned over to VS for Phase 2		488	488
-participated in NASS enumerator visit and declined to have name turned over to VS for Phase 2	0	10	10
Total selected by NASS	5045	1293	6338

<sup>a</sup> Out-of-scope operations included research farms, university farms, prison farms, etc.

Table 2

COFE Phase-2 participation rates by variables relating to the period from 1 July, 1993 to 30 June, 1994

Variable	Number of operations entitled to participate in Phase 2	Number of operations participating in Phase 2	Percent of participating operations relative to entitled operations
<i>Placed any dairy cattle</i>			
Yes	159	145	91.2
No	329	298	90.6
Not answered	10	10	100.0
<i>Placed both beef and dairy cattle</i>			
Yes	152	140	92.1
No	336	303	90.2
Not answered	10	10	100.0
<i>Placed any cows or bulls</i>			
Yes	48	42	89.4
No	441	401	90.9
Not answered	10	10	100.0
<i>Placed Mexican cattle</i>			
Yes	81	75	92.6
No	417	378	90.6
<i>Number of cattle placed</i>			
1 to 2499	158	135	85.4
2500 to 9999	144	131	91.0
10000 to 39999	120	116	96.7
40000 or more	76	71	93.4
<i>Used a veterinarian</i>			
Yes	493	448	90.9
No	5	5	100.0
<i>Used a nutritionist<sup>a</sup></i>			
Yes	443	407	91.9
No	55	46	83.6
<i>Hide-branded cattle</i>			
Yes	215	198	92.1
No	283	255	90.1

<sup>a</sup> Statistical significant difference ( $P < 0.05$ ) from  $\chi^2$  test.

0.01) among producers with a one-time capacity of fewer than 1000 cattle (61.4% of 1488) than among producers with larger capacity (49.8% of 1001). By state, Phase 1 participation ranged from 34.6% to 88.9%.

Table 3

Percent of operations that reported making program changes (during the 5 years prior to interview) due to concern for quality assurance or food safety

Program	Operations with capacity < 1000 cattle		Operations with capacity ≥ 1000 cattle		All operations	
	(%)	SE	(%)	SE	(%)	SE
Location or route of injections	27.0	2.7	83.0	1.4	29.6	2.7
Quality assurance training program	15.7	2.5	73.2	1.7	18.4	2.4

Table 4

Percent of cattle placed (from 1 July 1993 through 30 June 1994) on operations that reported making program changes (during the five years prior to interview) due to concern for quality assurance or food safety

Program	Operations with capacity < 1000 cattle		Operations with capacity ≥ 1000 cattle		All operations	
	(%)	SE	(%)	SE	(%)	SE
Location or route of injections	47.5	3.2	89.8	2.2	84.8	1.9
Quality assurance training program	27.3	3.1	87.2	2.1	80.1	1.9

Table 5

Of cattle placed on feed from 1 July 1993 through 30 June 1994, percent branded by site

Site	Operations with capacity < 1000 cattle		Operations with capacity ≥ 1000 cattle		All operations	
	(%)	SE	(%)	SE	(%)	SE
Neck/head	0.0	0.0	0.3	0.1	0.3	0.1
Shoulder	1.6	0.7	1.9	0.3	1.9	0.3
Side	3.1	1.8	1.6	0.2	1.8	0.3
Upper rear leg	10.4	2.1	15.4	1.5	14.8	1.3
Lower rear leg	0.7	0.7	1.0	0.3	0.9	0.2
Not hide branded	84.3	2.7	79.8	1.6	80.3	1.4

Table 6

For cattle-on-feed operations where vaccinations for clostridial diseases were given, percent of operations by route the clostridial vaccination was given

Route	Operations with capacity < 1000 cattle		Operations with capacity ≥ 1000 cattle		All operations	
	(%)	SE	(%)	SE	(%)	SE
Intramuscular	41.8	5.9	13.8	1.5	38.0	5.0
Subcutaneous	67.3	5.2	87.5	1.4	70.0	4.4

Table 7

For cattle-on-feed operations with a one-time capacity of 1000 or more cattle that gave all intramuscular vaccinations for clostridial diseases in one site, percent of operations using each site

Site	Percent of operations	
	(%)	SE
Neck/head	72.7	5.3
Shoulder	5.9	2.8
Side	1.3	0.9
Upper rear leg	18.4	4.6
Lower rear leg	1.7	1.4

### 3.1.2. Phase 2

Of the 498 operations with a one-time capacity of 1000 or more cattle that had participated in the Phase 1 of the COFE and that remained in business and had inventory at the time of the Phase 2 visit, 453 (91.0%) completed the second part of the study with the visiting veterinary medical officer. Ten declined during Phase 1 to have their names turned over to VS for Phase 2, seven were not accessible, and 28 refused to participate when contacted for Phase 2.

Three operations had either gone out of business or had zero inventory at the time of the veterinary medical officer's visit, and were excluded from the Phase 2 participation analysis.

By state, Phase 2 participation rates ranged from 75.0% to 100.0%.

Phase 2 participants were significantly more likely to have used a nutritionist than non-participants ( $\chi^2 = 4.04$ , d.f. = 1,  $P = 0.04$ ). Operations that had placed at least 2500 cattle-on-feed from 1 July 1993 to 30 June 1994 had a significantly higher Phase 2 participation rate than operations that had placed fewer cattle ( $\chi^2 = 8.58$ , d.f. = 1,  $P < 0.01$ ). Differences in participation rates for the other categorical variables examined were not significant (Table 2). The mean percent death loss from 1 July 1993 to 30 June 1994 for operations with 1000 head or greater capacity that did not participate in Phase 2 was significantly lower ( $0.88 \pm 0.12$ ) than the mean death loss rate for Phase 2 participants ( $1.29 \pm 0.10$ ).

### 3.2. Population estimates

Tables 3–7 present some examples of estimates tabulated for the cattle on feed industry (USDA, 1995). The estimates apply to cattle-on-feed operations in the 13 states included in the COFE.

## 4. Discussion

To date, a limitation of much of the research on livestock animals in the United States was that the research took place in controlled settings such as university or research farms, or was restricted to a small number of operations. Little basis often existed for extrapolating research results to the general population (King, 1990). During the 1980s, several NAHMS pilot studies were undertaken in a number of states to develop and test sampling designs and study methodologies (Bush and Gardner, 1995; Hueston, 1990; King, 1990). The first NAHMS national study, the 1990 National Swine Survey, was designed provide baseline information on swine management in the United States, and to collect, analyze, and report health events of sows and piglets during the farrowing period (USDA, 1992). The study was designed so that statistically valid inferences could be drawn to 95% of the United States swine population (USDA, 1992).

From the first NAHMS national study to the COFE, budgets allocated for NAHMS were sharply reduced. VS field staff years assigned for the COFE were roughly one-third of those deployed for the 1990 National Swine Survey. Over time, NAHMS staff acquired experience in designing studies that were targeted to specific objectives, questionnaires that were more concise and less of a burden to respondents, and products

that were more efficiently delivered. Each operation that completed the first NAHMS national study in 1990 provided over 3000 data items, many of which were never even summarized. A descriptive report was published one year after the data gathering portion of the study had ended (USDA, 1992). In contrast, most COFE participants furnished no more than 170 data items in a telephone survey (on-farm visits were restricted to operations with a one-time capacity of 1000 or more cattle). One descriptive report and three discussion sheets were delivered before the study's end (USDA, 1995), and additional reports followed soon after. A notable innovation initiated during the COFE was using the defined study objectives as the basis for creating table shells for the descriptive reports, and using the table shells, in turn, to create the survey questionnaires. In prior NAHMS surveys, little thought had often been devoted to the final product when the survey questionnaires were developed. This simple modification of developing output tables prior to questionnaire design helped to streamline processes, reduce respondent burden, and yield more timely, accurate, and useful products.

Unlike the first two NAHMS national studies (USDA, 1992; Heinrichs et al., 1994), the COFE relied solely upon sampling from the NASS lists of agricultural producers, and did not make use of area frames. An area frame is a census of all producers from randomly selected local land areas, and is used to adjust for incompleteness of the list frame (Heinrichs et al., 1994). Therefore, one limitation of the COFE is that the results did not take into account recent producer transition in and out of business.

The survey pretest allowed the state coordinators to become familiar with the survey instruments, so that they could more effectively train the enumerators. In addition, the pretest resulted in improvements to the questionnaires. The overall goal was to develop questionnaires that would meet the needs of feedlot operators of varying geography, management style, and operation size. An effort was made to make certain that questions would be interpreted the same way by producers and enumerators across the country.

One challenge for data validation was that, in the data file provided for NASS (for Phase 1 respondents), missing data were set to 0. Thus, distinguishing between real answers of 0 and missing values was at times difficult. Centers for Epidemiology and Animal Health personnel contacted NASS personnel to verify questionable Phase 1 data. Since Phase 2 questionnaires were sent directly to the Centers for Epidemiology and Animal Health for processing, Phase 2 data validation was considerably easier than Phase 1 data validation.

The participation rate computed for Phase 1 (56.7%) assumed that all of the operations that refused to participate in Phase 1 or were not accessible were qualified to participate in the COFE. Since we don't know how many of these operations were actually in business and had cattle at the time of attempted contact, the Phase 1 participation rate was conservatively estimated and may actually have been higher. The weighting procedure described above served to mitigate the effect of differing participation rates by region and operation size on the final estimates.

More than 90% of the operations that were entitled to participate in the second phase of the COFE completed the second phase of the COFE. In general, the comparisons between Phase 2 participants and non-participants indicated that the differences were not great, and that the participants reflected reasonably well the sample selected. The sample

weights of operations that were entitled to but did not participate in Phase 2 were redistributed to Phase 2 participants in the same region and operation size group. Thus, data users probably have little reason to be concerned about possible bias in the estimates.

However, people interpreting results from the COFE will have to bear in mind that most of the feedlot cattle in the United States were concentrated on a small percentage of the operations. During 1993, 205 operations (0.5% of all operations) with a one-time capacity of 16 000 or more cattle marketed more than half (57.8%) of the feedlot cattle in the 13 states included in the study (Cattle on Feed Report No. Mt An 2-1 (2-94), released 18 February 1994 by the USDA: NASS: Agricultural Statistics Board). Operations with a one-time capacity of 8,000 or more cattle accounted for 0.8% of the operations and marketed 70.1% of the cattle. Thus, in the COFE descriptive reports, separate estimates were given for operations with a one-time capacity of less than 1000 cattle and for operations with a one-time capacity of 1000 or more cattle (USDA, 1995).

For example, Table 3 shows that  $27.0 \pm 2.7\%$  of small feedlots and  $83.0 \pm 1.4\%$  of larger feedlots reported some change in injection practices (i.e. site, route) in the 5 years prior to the survey. Since the vast majority (96.0%) of operations represented by the study had a one-time capacity of fewer than 1000 cattle, the estimated percent of all cattle-on-feed operations that changed injection practices in the five years prior to the survey was considerably closer to the estimate for small operations than the estimate for large operations. Similarly for operations that reported a change in, or development of, quality assurance training for feedlot workers. However, when one examines percent of cattle (Table 4), one sees that the majority of cattle placed on feedlots from 1 July 1993 through 30 June 1994 were on operations that reported making the program changes during the 5 years prior to the survey. Concerns about quality and food safety have had impacts on cattle feeders (Jones et al., 1992; Van Dresser, 1991). Since many small feedlots may only employ the owner and the owner's family members, implementation of or changes to a quality assurance training program may have been irrelevant for many operations in this size group.

The hide is an important product of the cattle industry (Frye, 1995). Branding can result in loss of value to the hide, the amount of loss depending upon the location (Frye, 1995). Overall,  $19.7 \pm 1.4\%$  of cattle placed in feedlots were branded at the feedlot. Although freeze-branding has been recommended as an alternative to hot-iron branding because freeze-branding does not cause significant damage to the hide (Field, 1992), the COFE questionnaire did not distinguish between hot-iron branding and freeze branding. The most common location for branding in the feedlot was the upper rear leg or hip (Table 5). Field (1992) estimated that a hot-iron brand in the side reduced the value of a hide by \$14.69, while a hot-iron brand behind the rear flank diminished the value of a hide by \$9.46. Assuming a \$10 loss per branded hide and that 20% of the 22 million feedlot cattle marketed in the 13 states were hide-branded at the feedlot, the total loss to the industry from hide-branding at the feedlot may have amounted to roughly \$44 million during 1993. If more of the cattle had been hot-iron branded in the side, losses would have been greater. However, since we don't know what percent of cattle were hot-iron branded and what percent were freeze-branded, we can't know precisely how much money was lost due to branding.

Injection-site lesions represent another quality concern for the beef industry (Dexter et al., 1994). Much concern has centered around multivalent vaccination for clostridial diseases (Smith, 1992). Of cattle on feed operations with a one-time capacity of 1000 or more cattle,  $91.0 \pm 1.2\%$  vaccinated for clostridial diseases, compared with  $34.0 \pm 3.1\%$  of smaller operations. Of all cattle placed on feed from 1 July 1993 to 30 June 1994,  $86.5 \pm 1.1\%$  received vaccinations for clostridial diseases.

Intramuscular injections are associated with tissue damage and subsequent loss in value of the carcass (Dexter et al., 1994). No producer indicated giving vaccinations for clostridial diseases by any route other than intramuscular or subcutaneous (Table 6).

For feedlot operations with a one-time capacity of 1000 or more cattle, the region of the head and neck was the most common site of intramuscular injections of vaccines for clostridial diseases (Table 7). Smaller operations were not asked about sites of injections of vaccines for clostridial diseases.

Multiple vaccinations (at the same time or at different times) may increase the likelihood of a lesion, which diminishes the value of a carcass (Smith, 1992). For operations where vaccinations for clostridial diseases were given,  $22.8 \pm 1.5\%$  of cattle received more than one clostridial injection.

The 1994 Cattle on Feed Evaluation provided management information from feedlot operations representing 85.8% of the cattle inventory on feedlot operations in the United States. Baseline measurements relating to management practices such as quality assurance measures, including branding and injection practices, were collected and summarized. With this information, those who influence decision-making in feedlots can make changes leading to better quality products and improved health.

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